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NUTRIENT INTAKES AND WORK PERFORMANCE OF SOLDIERS DURING SEVEN DAYS OF EXERCISE AT 7,200 FEET ALTITUDE CONSUMING THE MEAL, READY-TO-EAT RATION

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

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UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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The Meal, Ready-To-Eat (MRE) ration was fed ad libitum to a group of 15 soldiers for a period of 12 days. Ten of the 12 days were spent under field conditions at moderate (7,200 feet) altitude. Seven of the 10 days at altitude were exercise days wherein the soldiers ran a strenuous cross-country course (9-11 miles) for 2 hr/day. Caloric intakes were less than adequate for energy balance under these conditions. During the 10-day exercise period, soldiers consumed less than 67% of the calories recommended for energy balance. The soldiers lost 3% of their body weight, 10% of their body fat, and experienced a decline of 5% in their maximal aerobic capacity. Although calcium, iron, and riboflavin intakes were suboptimal, the most potentially serious deficiency noted was the low (260 g/day) intake of carbohydrate. No remarkable changes in blood chemistries other than an increased level of ketone bodies were noted. Although the MRE ration supported a reasonable level of performance under these conditions, it is recommended that the ration be supplemented by a carbohydrate source during periods of exertion at altitude.

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HUMAN RESEARCH

Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

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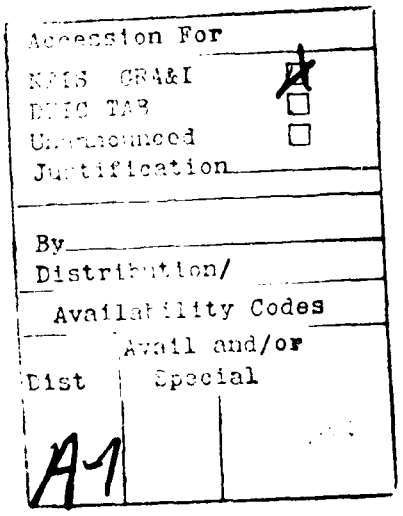

USARIEM TECHNICAL REPORT

NUTRIENT INTAKES AND WORK PERFORMANCE OF SOLDIERS DURING SEVEN DAYS OF EXERCISE AT 7,200 FEET ALTITUDE CONSUMING THE MEAL, READY-TO-EAT RATION*

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ABSTRACT

The Meal, Ready-To-Eat (MRE) ration was fed ad libitum to a group of 15 soldiers for a period of 12 days. Ten of the 12 days were spent under field conditions at moderate (7,200 feet) altitude. Seven of the 10 days at altitude were exercise days wherein the soldiers ran a strenuous cross-country course (9-11 miles) for 2 hr/day. Caloric intakes were less than adequate for energy balance under these conditions. During the 10-day exercise period, soldiers consumed less than 67% of the calories recommended for energy balance. The soldiers lost 3% of their body weight, 10% of their body fat, and experienced a decline of 5% in their maximal aerobic capacity. Although calcium, iron, and riboflavin intakes were suboptimal, the most potentially serious deficiency noted was the low (260 g/day) intake of carbohydrate. No remarkable changes in blood chemistries other than an increased level of ketone bodies were noted. Although the MRE ration supported a reasonable level of performance under these conditions, it is recommended that the ration be supplemented by a carbohydrate source during periods of exertion at altitude.

INTRODUCTION

A new packaged field ration has been developed by the U.S. Army Natick Research, Development, and Engineering Center (1). The Meal, Ready-To-Eat (MRE) ration is packaged in a lightweight flexible pouch to furnish combat troops a nutritious food product especially suited to field situations due to its light weight and limited requirement for preparation prior to consuming.

This ration has been tested and approved for 10-14 days of continuous use (2). Feeding trials for prolonged periods of 34 days (2) and 45 days (3) have shown this ration to be generally acceptable, with some reservations (2). Although this ration has been tested under military field conditions at 6,100 feet elevation (2), a carefully controlled exercise study at moderately high altitude had not been done. Since suboptimal caloric intakes had been reported in the 34-day study at 6,100 feet altitude, it was decided to test the MRE ration as the sole nutrient source during seven continuous days of strenuous cross-country running at 7,200 feet altitude. We hoped to answer one basic questions: Will soldiers consume adequate amounts of the MRE ration to sustain seven days of exercise at moderate altitude under field conditions? Data on food and water consumption, anthropometric measurements, urine volume, maximal aerobic capacity, and selected blood and urine chemistries were collected by the Department of Clinical Investigation, Tripler Army Medical Center during the month of July 1984 at sea level and at 7,200 feet altitude at Pohakuloa Training Area, Hawaii.

METHODS

Test Site

The experiment took place at two sites, sea level (Tripler Army Medical Center (TAMC) on the island of Oahu) and 7,200 feet altitude (Pohakuloa Training Area (PTA) on the island of Hawaii). The elevation at PTA is approximately 6,100 feet, and the test site was at a remote location 9 1/2 miles from PTA at 7,200 feet altitude. The climate was warm during the day (70°F) but cool (40°F) at night. During the morning when the subjects ran, the temperature averaged 16.1±0.9°C (61°F) and 78.0±4.5% relative humidity. The site was dry and dusty at midday but heavy morning and evening mists caused chilly conditions to prevail at these time periods. The site was remote (9 1/2 miles from PTA, 25 miles from Hilo, and 1 1/2 miles from the nearest paved road). These conditions minimized the availability of non-MRE food. The subjects remained in the field except for a 1 1/2 hour bus ride daily to PTA and back for showers.

Test Subjects

The test subjects were active duty enlisted soldiers from the 25th Infantry Division, Schofield Barracks, 45th Support Group, Ft. Shafter, and Tripler Army Medical Center. Fifteen soldiers volunteered for the study after signing informed consent agreements approved by the Tripler Army Medical Center Clinical Investigation and Human Use Committees. Soldiers of average physical fitness were selected. No active marathon class runners were selected. Subjects had to have passed the most recent Armed Forces Physical Readiness Test, a pre-study physical examination, and a treadmill stress test. They agreed to consume only MRE food items during the test. No

alcoholic beverages were permitted. Anthropometric data on the test subjects are shown in Table 1.

Anthropometric Measurements

Height was measured in stocking feet. Body weights were measured in running shorts and t-shirts without shoes with a swinging beam balance accurate to the nearest 1/8 pound. Percent body fat was estimated from the sum of 4 skinfold thickness measurements according to the memorandum for Army Dietitians and Physical Therapists dated 30 January 1983. The sites measured were biceps, triceps, subscapular, and suprailiac. Measurements were taken in triplicate to the nearest 0.1 mm on the right side of the body. These skinfolds were calipered by the same Army-credentialled anthropometrist before and after the 14-day study. Percent body fat was calculated from the sum of these four mean values according to the formula of Durnin and Womersley (4).

Experimental Design

The 15 volunteers were initially divided into two groups of 7 and 8, matched according to their maximal aerobic capacity (VO_2max). Group I began running the day after arriving at altitude. Group II rested at altitude for 3 days before beginning the running program. Each group ran for 7 consecutive days. The subjects had been divided into two groups to test for the effects of acclimatization. Since no effects were noted and both groups gave similar responses to exercise and food intake, the data during the seven days of exercise were combined to give an N of 15. These are the data that will be presented in several of the summary tables in this paper.

The experiment consisted of 3 periods. Period I was the pre-exercise period that consisted of the days at sea level and days at altitude prior to running. Period II consisted of 7 days of running at altitude. Period III consisted of the days post-run at both altitude and sea level. Subjects were at sea level for the first 2 days for baseline measurements, then at altitude for the next 10 days, and then at sea level for one final day of measurements. The total duration of the experiment was 14 days. Subjects started on the MRE ration at 0800 hours on day 1. The data from day 1 were not included in this experiment since the soldiers were adjusting to the new surroundings and food. Food intake data started on day 2 and continued through day 13. The data from day 14 were not included since complete data could not be obtained because most of the day was devoted to the final VO_2max determination.

VO_2max Determination

Subjects were tested for maximal oxygen uptake capacity on day 1 and day 14. VO_2max was determined similar to McArdle et al (5) using a Sensor Medics MMC-Horizon Metabolic Testing System (6) and and elevating treadmill. The subjects were required to sit resting for 90 seconds, then walk at 3 1/2 miles/hr at 0° grade for 2 minutes. The speed of the treadmill was then increased to 6 miles/hr and held constant. Every 2 minutes, the grade was increased 2 1/2% until O_2 uptake plateaued or decreased.

Exercise Protocol

The subjects were not permitted to eat from midnight until after the 2-hour run the next morning. Runners were started in intervals of 5 minutes beginning at 0800 hours. All runners finished running before 1100 hours.

Runners were instructed to run at a comfortable pace for as long as possible during the 2-hour run period. Walking was permitted if the exertion level became too intense, but runners were encouraged to resume running as soon as they had "caught their breath." The route was a cinder road that traversed through open country and varied between 7000 and 7200 feet elevation. Changes in elevation, although small, were usually abrupt, increasing the exertion level significantly. The course was laid out to permit runners to cover as many miles as they felt comfortable with in two hours. Three aid stations were interspersed at 2-mile intervals on the course. Runners were offered water and heart rates and blood pressures were taken at these points during the run.

Collection of Blood and Urine Samples

Resting venous blood samples were taken at 0800 hours on day 1 for sea level control values. Blood samples were subsequently taken pre- and post-exercise on the first, fourth, and seventh days of running. Resting blood samples were taken at 0800 hours each morning following the seventh day of exercise until the completion of the experiment. Serum samples were analyzed by an automated panel of blood chemistries (SMAC-20). High density lipoprotein cholesterol (HDL) was analyzed by a commercial method (7). B-hydroxybutyrate (8), glycerol (9), and lactate (10) were analyzed by enzymatic methods.

Twenty-four hour urine collections were made each day of the experiment. Urine and blood samples were transported on ice to PTA base camp where they were processed and aliquots frozen for subsequent analysis. Urine B-hydroxybutyrate was analyzed by the same method utilized for serum (8).

MRE Ration Consumption

Each subject received a case of MRE rations containing 12 menu pack meals (1200 kcal/meal). Each individual was free to choose any meal for consumption at any time following the two hour morning run. They could eat as much as they wanted and trade meals or components with other subjects as long as they recorded what they ate. When the 12 meals were used up, another case of 12 meals was issued. They were instructed to fill out a MRE food record card (Appendix 1) whenever they opened and ate a meal packet. Food items consumed between meals were recorded on the next food record card. Hot water pans and large urns filled with hot water were made available in the mess tent for heating MRE food items. Water intake records were logged at the water point each time a subject consumed water, coffee, or cocoa. Diet soft drinks were available as an alternative fluid source. Cans of diet soft drinks consumed were recorded on the MRE food record card. Food record cards were collected daily by squad leaders. Hot sauce was permitted as an ad libitum seasoning.

Upon 5 occasions during the 7-day exercise period, food record cards were either not turned in or lost by one or more of the subjects. Omitting these food intakes resulted in decreased overall nutrient intakes of 4-5%. Follow-up interviews with the subjects verified that food had been consumed. It was felt that generating missing values would result in a smaller error than the 4-5% error that would have resulted from using zero intake values. The missing data was generated by deriving representative mean values from previous recorded food record cards for the individual in question.

Nutrient Composition

The nutrient composition of the 12 MRE rations was determined by referring to a nutrient factor file dated 3/26/81 (LP/P DES 33 74A) published by the U.S. Army Natick Research and Development Center. Quantities of foods consumed were extracted from the MRE Food Record Card and processed by applying the values from the nutrient factor file utilizing data reduction programs developed by the University of Hawaii and the Statistical Analysis System (SAS), SAS Institute, Inc., Cary, NC 27511.

Statistical Analysis

Differences between groups and between periods for food and nutrient intakes was tested by a non-paired t-test utilizing the F' (folded) statistic (11). Body weight changes, body fat changes, blood chemistries, and VO_2 max changes were tested by a paired t-test (12). Significant differences reported are $P<0.05$. Mean values are reported with the standard error of the mean as an estimate of variability.

RESULTS

General

The first day of the experiment, 15 July, was used as a dietary adaptation period. Records were taken for practice but not used. Dietary intake records were started on 16 July and ended on 27 July. The 17th consisted of the move from sea level to altitude and the 27th consisted of the move from altitude back to sea level.

Group Comparisons

Daily nutrient intakes for group I are shown in Tables 2a,b, and c. Table 2d lists the 12-day mean intakes for group I. This includes food consumed at sea level, at altitude, and during days of rest and exercise. Exercise commenced on 18 July for group I and ended on 24 July.

Daily nutrient intakes for group II are shown in Tables 3a, b, and c. Table 3d lists the 12-day mean intakes for group II. Exercise commenced on 20 July for group II and ended on 26 July.

There were no significant differences between group mean daily nutrient intakes shown in Tables 2d and 3d.

Group - Period Comparisons

The intake of nutrients by group during the pre-exercise period is shown in Table 4a. Since there were no significant group differences in nutrient intakes during the pre-exercise period, the data for both groups were combined in Table 4b for a mean pre-exercise value.

The intake of nutrients by group during their seven-day exercise period is shown in Table 5a. Once again, there were no significant differences between the two groups, so both groups were combined to provide a mean daily nutrient intake during the exercise period (Table 5b).

Tables 6a and b show nutrient intakes during the post-exercise period. Low values were recorded on 27 July, the transition day back to sea level. Food records were probably not complete on this day due to the distractions of breaking camp and traveling back to Oahu.

For comparative purposes, the data from Tables 2d and 3d is shown in Table 7. There was no significant differences between intakes of any of the

nutrients between groups I and II; thus, we felt justified in combining the data for both groups into a 12-day mean of 180 man-days of food intakes (Table 8).

Exercise Period Nutrient Intakes Compared to Recommended Intakes

Tables 9a and b show the mean daily nutrient intakes during the 7-day exercise period for the combined data of both groups I and II. Table 9c expresses the 7-day mean food intakes as a percent of military recommended dietary allowances (MRDA) published in AR 40-25 (13). The recommended value for fat (160 g) is a dietary maximum for operational ration content, lower limits have not been established.

It can be seen that during the seven days of exercise, caloric intakes were suboptimal. This was particularly apparent in the reduced carbohydrate intakes. Despite inadequate caloric intakes, the protein intakes were adequate. Phosphorus, iron, vitamin A, vitamin C, thiamin, riboflavin, niacin and pyridoxine intakes were all adequate or in excess of the MRDA. However, calcium and magnesium intakes were 25% less than the MRDA.

Frequency of MRE Foods Consumed

Tables 10a-i show the number (frequency) and percent of total selections in that class for each food item in the MRE during the 12-day experiment. Not all classes of foods appeared in the meal packets in equal frequencies so these intake selections do not represent true food item preferences except perhaps in the entree class.

Anthropometric Measurements

Pre- and post-experiment (day 1 and day 12) body weights and percent body fat are shown in Table 11. Subjects lost an average of 4.4 pounds and 1.5%

body fat during the 12 days of consuming the MRE ration. Body weights at the beginning of each day's run are shown in Table 12.

Fluid Intakes and Urine Volumes

Water from fluids ranged from 2.0 to 2.9 liters/day and total water intake, including food source water, ranged from 2.5 to 3.3 liters/day (Table 12).

Urine volumes (ml/24 hrs) for the seven days of running with both groups combined ranged from 742-965 ml/man/day for days 1-7 of running (Table 12).

Maximal Oxygen Uptake

VO_2max decreased significantly ($P < 0.01$) pre- to post-experiment despite 7 days of strenuous training (Table 11). This decrease was significant whether the oxygen uptake was expressed as L/min, L/min/kg body weight, or L/min/kg lean body mass.

Workload Achieved

Table 12 shows the mean daily mileage achieved during the 7 days of running. The mean maximum pre-experiment heart rate was 198.5±2.2. The mean daily heart rate recorded during running was 156.0±2.2, which was 79.0±1.1% of their maximum heart rate. This corresponds to a perceived exertion level of "very heavy".

Blood Chemistries

A summary of blood chemistry values is shown in Table 13. These samples all represent 0800 resting values and were collected at the beginning of the experiment (day 1), prior to the first day of exercise at altitude, prior to the fourth day of exercise at altitude, prior to the seventh day of exercise at altitude, and finally at the end of the experiment (day 13). Sodium,

potassium, glucose, albumin, total protein and lactate were significantly elevated upon going to altitude. Creatinine and glycerol were significantly elevated after 2 days at altitude. Due to the design of this experiment, it is impossible to separate the effects of altitude from exercise.

Blood and urine samples were analyzed for Beta-hydroxybutyrate. These results showed that ketone bodies increased in the blood and urine over the course of this experiment, indicative of a negative energy balance (Table 14).

DISCUSSION

The MRE food record card has been previously shown to be a reliable method of estimating food intakes under field conditions--at least as accurate as the food wrapper collection method (2). We found the card to be easy to use, but probably is a conservative estimate of food intake since it is possible to forget to mark an item (especially a snack) on the card. In this study, 5 out of 105 man-day food intakes were missing during the 7-day run period indicating a subject either did not eat, forgot to fill out a card, or the card was lost or misplaced. Replacing missing data with mean intakes generated from the individual's previous and subsequent food intakes minimized this type of error.

This study was not specifically designed to study pre-exercise, exercise, and post-exercise food intakes; however, caloric intake did increase from 2040 kcal pre-exercise to 2390 kcal during the exercise period. The 2390 kcal intake during exercise was 67% of the 3600 kcal level recommended for this type of energy expenditure. The caloric deficit was reflected in a significant loss of body weight. The 3% loss of body weight during the 12-

day experiment was well below the 10% level of concern and consisted mainly of loss from the body fat component. The loss of body fat and positive urine and blood ketones indicated that fat was serving as a major energy source during exercise. The recorded carbohydrate intakes of only 263 g per day (44% of the calories) were very similar to the low carbohydrate diet (40% of the calories) that Sherman and Costill (14) employed to illustrate the inability of a low carbohydrate diet to maintain muscle glycogen levels with daily strenuous exercise. To store or replace a predicted daily muscle glycogen loss of 40-60 mmol/kg body weight, aproximately 500 g of carbohydrate would need to be consumed per day. The 263 g/day level of carbohydrate consumption found in this study would support a glycogen repletion rate of only 10 mmol/kg/24 hrs. Calculations such as these serve to predict that muscle glycogen depletion was probably occurring midway through the 7-day run. This contention is further supported by the increased levels of blood and urine ketone bodies found midway through this experiment. It is not known if this probable depletion of muscle glycogen due to inadequate carbohydrate intake and heavy repetitive exercise contributed to the 5% decrease in VO_2max observed in this experiment.

Nutrient intakes other than kcal, carbohydrate, calcium and magnesium were adequate. Although calcium and magnesium intakes were less than recommended, it is unlikely that such short-term, limited intakes of these nutrients would have a significant affect on performance. Chronic intakes of this nature for long-term periods would be deleterious to the nutritional status of the soldier. These nutrient intakes are very similar to those observed for a 34-day time period at 6100 feet altitude under field maneuver

conditions (2). Blood chemistries showed some significant increases/decreases probably attibutable to altitude, exercise, and/or negative energy status. These values, in general, were within the range of normal values and did not indicate any ration related perturbations other than sub-optimum energy intakes.

CONCLUSION

Work performance during this study was maintained for the 7-day exercise period, based upon the voluntary mileage run/day. It is not known if the suboptimal caloric and carbohydrate intakes recorded in this experiment would have become limiting to performance in a longer term experiment, but such projections would not seem unreasonable. Therefore, we conclude that the MRE ration consumed for a 12-day time period adequately supported 7 continuous days of heavy exercise at 7,200 feet altitude but was consumed in quantities insufficient to meet caloric needs and probably insufficient to replenish muscle glycogen levels. We would project that fatigue problems arising from depleted muscle glycogen levels might be manifested in similar situations lasting longer than 7 days. We recommend that a carbohydrate supplement be considered for implementation in situations where caloric and carbohydrate intakes are reduced.

TABLE 1: ANTHROPOMETRIC DESCRIPTION OF SUBJECTS[1]

Age (yr)	Height (in)	Weight (lbs)	Body Fat (%)	Initial VO_2max (L/min)
23.3±1.2	67.6±0.6	155.5±6.5	14.8±0.9	3.88±0.13

[1]The 15 volunteers were active duty soldiers from the 25th Infantry Division, Schofield Barracks; 45th Support Group, Ft. Shafter; and Tripler Army Medical Center.

Table 2a
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : I

	DATE							
	16JUL		17JUL		18JUL		19JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	105	7	75	7	122	7	98	7
FAT, g	107	7	87	7	128	7	108	7
CARBOHYDRATES, g	245	7	178	7	316	7	251	7
K CALORIES	2366	7	1797	7	2902	7	2371	7
CALCIUM, mg	591	7	497	7	731	7	628	7
PHOSPHORUS, mg	1416	7	1100	7	1791	7	1425	7
IRON, mg	14.5	7	10.9	7	16.3	7	14.3	7
SODIUM, mg	5716	7	4096	7	6022	7	5124	7
POTASSIUM, mg	2517	7	1802	7	3073	7	2438	7
MAGNESIUM, mg	255	7	187	7	313	7	248	7
TOTAL VIT. A, IU	6471	7	6611	7	12166	7	7640	7
VIT. C, mg	111	7	98	7	193	7	142	7
THIAMIN, mg	4.2	7	3.8	7	5.9	7	4.9	7
RIBOFLAVIN, mg	2.0	7	1.5	7	2.3	7	2.1	7
NIACIN, mg	24.3	7	16.5	7	25.8	7	22.7	7
PYRIDOXINE, mg	2.7	7	3.2	7	5.8	7	3.7	7
WATER FROM FOOD, g	423	7	264	7	444	7	315	7
WATER FROM FLUIDS, g	3127	7	2541	7	2027	7	3072	7
TOTAL WATER, g	3550	7	2806	7	2471	7	3386	7
TOTAL FOOD, g	903	7	621	7	1037	7	794	7
TOTAL FOOD, DRY WT	489	7	357	7	553	7	479	7

Table 2b
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : I

	DATE							
	20JUL		21JUL		22JUL		23JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	85	7	103	7	120	7	123	7
FAT, g	82	7	104	7	110	7	117	7
CARBOHYDRATES, g	248	7	274	7	270	7	299	7
K CALORIES	2064	7	2441	7	2552	7	2746	7
CALCIUM, mg	528	7	632	7	613	7	667	7
PHOSPHORUS, mg	1232	7	1525	7	1623	7	1716	7
IRON, mg	12.3	7	14.4	7	15.7	7	17.4	7
SODIUM, mg	4285	7	5479	7	5697	7	6241	7
POTASSIUM, mg	2166	7	2642	7	2750	7	3025	7
MAGNESIUM, mg	200	7	265	7	256	7	293	7
TOTAL VIT. A, IU	7978	7	9944	7	7344	7	10011	7
VIT. C, mg	121	7	127	7	146	7	142	7
THIAMIN, mg	4.2	7	4.5	7	4.5	7	5.0	7
RIBOFLAVIN, mg	1.9	7	2.0	7	2.1	7	2.2	7
NIACIN, mg	19.6	7	21.6	7	25.5	7	25.1	7
PYRIDOXINE, mg	3.3	7	4.5	7	4.0	7	4.6	7
WATER FROM FOOD, g	307	7	445	7	394	7	469	7
WATER FROM FLUIDS, g	3096	7	2039	7	3347	7	2827	7
TOTAL WATER, g	3403	7	2484	7	3741	7	3296	7
TOTAL FOOD, g	740	7	950	7	918	7	1035	7
TOTAL FOOD, DRY WT	433	7	504	7	524	7	566	7

Table 2c
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : I

	DATE							
	24JUL		25JUL		26JUL		27JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	108	7	117	7	79	7	107	7
FAT, g	121	7	137	7	88	7	112	7
CARBOHYDRATES, g	257	7	300	7	241	7	244	7
K CALORIES	2548	7	2895	7	2067	7	2406	7
CALCIUM, mg	715	7	799	7	544	7	607	7
PHOSPHORUS, mg	1629	7	1935	7	1230	7	1515	7
IRON, mg	15.6	7	15.6	7	12.3	7	14.3	7
SODIUM, mg	5986	7	6354	7	4151	7	5414	7
POTASSIUM, mg	2734	7	2775	7	2098	7	2275	7
MAGNESIUM, mg	256	7	269	7	217	7	226	7
TOTAL VIT. A, IU	10512	7	12543	7	8179	7	7672	7
VIT. C, mg	183	7	206	7	112	7	97	7
THIAMIN, mg	5.8	7	6.4	7	4.3	7	4.9	7
RIBOFLAVIN, mg	1.9	7	2.2	7	1.7	7	2.2	7
NIACIN, mg	22.0	7	23.4	7	18.0	7	21.8	7
PYRIDOXINE, mg	5.3	7	6.1	7	3.5	7	3.5	7
WATER FROM FOOD, g	351	7	392	7	308	7	415	7
WATER FROM FLUIDS, g	2596	7	2471	7	2142	7	2335	7
TOTAL WATER, g	2947	7	2862	7	2450	7	2751	7
TOTAL FOOD, g	862	7	970	7	733	7	899	7
TOTAL FOOD, DRY WT	511	7	579	7	425	7	484	7

Table 2d
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : I

	All Days	
	Daily Mean Intake	N
PROTEIN, g	104	84
FAT, g	108	84
CARBOHYDRATES, g	260	84
K CALORIES	2429	84
CALCIUM, mg	629	84
PHOSPHORUS, mg	1511	84
IRON, mg	14.5	84
SODIUM, mg	5380	84
POTASSIUM, mg	2525	84
MAGNESIUM, mg	249	84
TOTAL VIT. A, IU	8922	84
VIT. C, mg	140	84
THIAMIN, mg	4.9	84
RIBOFLAVIN, mg	2.0	84
NIACIN, mg	22.2	84
PYRIDOXINE, mg	4.2	84
WATER FROM FOOD, g	377	84
WATER FROM FLUIDS, g	2635	84
TOTAL WATER, g	3012	84
TOTAL FOOD, g	872	84
TOTAL FOOD, DRY WT	494	84

Table 3a
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : II

	DATE							
	16JUL		17JUL		18JUI		19JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	100	8	78	8	77	8	103	8
FAT, g	81	8	74	8	80	8	104	8
CARBOHYDRATES, g	187	8	180	8	238	8	279	8
K CALORIES	1881	8	1694	8	1979	8	2459	8
CALCIUM, mg	478	8	329	8	483	8	562	8
PHOSPHORUS, mg	1243	8	1034	8	1218	8	1476	8
IRON, mg	12.6	8	9.4	8	11.9	8	14.6	8
SODIUM, mg	4824	8	4159	8	4062	8	5431	8
POTASSIUM, mg	2102	8	1648	8	1944	8	2678	8
MAGNESIUM, mg	220	8	170	8	202	8	267	8
TOTAL VIT. A, IU	4232	8	3441	8	6102	8	8116	8
VIT. C, mg	74	8	55	8	85	8	118	8
THIAMIN, mg	3.2	8	2.4	8	3.4	8	4.6	8
RIBOFLAVIN, mg	1.8	8	1.3	8	1.5	8	1.9	8
NIACIN, mg	25.4	8	19.6	8	17.3	8	23.2	8
PYRIDOXINE, mg	2.1	8	1.8	8	3.0	8	3.8	8
WATER FROM FOOD, g	374	8	261	8	306	8	354	8
WATER FROM FLUIDS, g	2127	8	2024	8	1922	8	2592	8
TOTAL WATER, g	2501	8	2285	8	2227	8	2946	8
TOTAL FOOD, g	762	8	609	8	718	8	863	8
TOTAL FOOD, DRY WT	388	8	347	8	412	8	509	8

Table 3b
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : II

	DATE							
	20JUL		21JUL		22JUL		23JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	100	8	110	8	109	8	90	8
FAT, g	99	8	101	8	98	8	96	8
CARBOHYDRATES, g	286	8	256	8	262	8	240	8
K CALORIES	2430	8	2371	8	2362	8	2184	8
CALCIUM, mg	568	8	612	8	592	8	493	8
PHOSPHORUS, mg	1391	8	1523	8	1500	8	1279	8
IRON, mg	14.9	8	15.7	8	16.3	8	13.7	8
SODIUM, mg	5472	8	5828	8	5642	8	5023	8
POTASSIUM, mg	2818	8	2758	8	2974	8	2556	8
MAGNESIUM, mg	265	8	282	8	300	8	247	8
TOTAL VIT. A, IU	8148	8	8303	8	8131	8	6674	8
VIT. C, mg	110	8	125	8	116	8	100	8
THIAMIN, mg	4.1	8	4.7	8	4.1	8	3.7	8
RIBOFLAVIN, mg	1.9	8	1.8	8	1.8	8	1.5	8
NIACIN, mg	21.7	8	24.6	8	23.4	8	19.1	8
PYRIDOXINE, mg	3.9	8	4.1	8	3.5	8	3.3	8
WATER FROM FOOD, g	405	8	449	8	491	8	341	8
WATER FROM FLUIDS, g	2111	8	2478	8	2720	8	2719	8
TOTAL WATER, g	2516	8	2927	8	3211	8	3060	8
TOTAL FOOD, g	912	8	940	8	983	8	788	8
TOTAL FOOD, DRY WT	507	8	490	8	491	8	447	8

Table 3c
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : II

	DATE							
	24JUL		25JUL		26JUL		27JUL	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	86	8	100	8	101	8	83	8
FAT, g	78	8	102	8	100	8	73	8
CARBOHYDRATES, g	227	8	225	8	282	8	173	8
K CALORIES	1952	8	2218	8	2429	8	1682	8
CALCIUM, mg	462	8	551	8	609	8	423	8
PHOSPHORUS, mg	1146	8	1413	8	1412	8	1099	8
IRON, mg	13.8	8	14.3	8	16.0	8	12.1	8
SODIUM, mg	4529	8	5490	8	5641	8	4784	8
POTASSIUM, mg	2339	8	2457	8	2919	8	2272	8
MAGNESIUM, mg	229	8	243	8	281	8	199	8
TOTAL VIT. A, IU	5395	8	6142	8	7061	8	4507	8
VIT. C, mg	69	8	104	8	116	8	65	8
THIAMIN, mg	3.4	8	4.3	8	4.4	8	2.6	8
RIBOFLAVIN, mg	1.6	8	1.6	8	1.8	8	1.4	8
NIACIN, mg	18.3	8	23.1	8	23.2	8	16.7	8
PYRIDOXINE, mg	2.5	8	3.2	8	3.7	8	2.2	8
WATER FROM FOOD, g	368	8	367	8	390	8	332	8
WATER FROM FLUIDS, g	2154	8	2154	8	2365	8	2224	8
TOTAL WATER, g	2522	8	2521	8	2756	8	2556	8
TOTAL FOOD, g	778	8	816	8	897	8	679	8
TOTAL FOOD, DRY WT	410	8	449	8	506	8	348	8

Table 3d
Mean Daily Intake of Energy and Nutrients : Daily Basis

GROUP : II

	All Days	
	Daily Mean Intake	N
PROTEIN, g	95	96
FAT, g	90	96
CARBOHYDRATES, g	236	96
K CALORIES	2137	96
CALCIUM, mg	514	96
PHOSPHORUS, mg	1311	96
IRON, mg	13.8	96
SODIUM, mg	5074	96
POTASSIUM, mg	2455	96
MAGNESIUM, mg	242	96
TOTAL VIT. A, IU	6354	96
VIT. C, mg	95	96
THIAMIN, mg	3.7	96
RIBOFLAVIN, mg	1.7	96
NIACIN, mg	21.3	96
PYRIDOXINE, mg	3.1	96
WATER FROM FOOD, g	370	96
WATER FROM FLUIDS, g	2299	96
TOTAL WATER, g	2669	96
TOTAL FOOD, g	812	96
TOTAL FOOD, DRY WT	442	96

Table 4a
Intake of Energy and Nutrients: Rest, Pre-exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	GROUP							
	I: 7/16-17				II: 7/16-19			
	N	Daily Mean Intake	STD DEV	STD ERR	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	7	90.5	22.7	8.6	8	89.7	21.2	7.5
FAT, g	7	97.1	21.3	8.1	8	84.5	26.4	9.3
CARBOHYDRATES, g	7	211.7	72.7	27.5	8	221.0	67.1	23.7
K CALORIES	7	2081.3	543.8	205.5	8	2003.0	544.8	192.6
CALCIUM, mg	7	543.9	154.6	58.4	8	463.1	180.2	63.7
PHOSPHORUS, mg	7	1257.8	293.2	110.8	8	1242.9	341.8	120.8
IRON, mg	7	12.7	3.6	1.3	8	12.1	2.3	0.8
SODIUM, mg	7	4906.1	1276.6	482.5	8	4618.9	829.0	293.1
POTASSIUM, mg	7	2159.9	700.9	264.9	8	2093.0	405.6	143.4
MAGNESIUM, mg	7	221.2	67.3	25.4	8	214.9	62.0	21.9
TOTAL VIT. A, IU	7	6541.1	2556.2	966.2	8	5472.5	2856.5	1009.9
VIT. C, mg	7	104.5	25.7	9.7	8	83.0	44.6	15.8
THIAMIN, mg	7	4.0	1.3	0.5	8	3.4	1.7	0.6
RIBOFLAVIN, mg	7	1.7	0.5	0.2	8	1.6	0.6	0.2
NIACIN, mg	7	20.4	6.3	2.4	8	21.4	6.8	2.4
PYRIDOXINE, mg	7	3.0	1.1	0.4	8	2.7	1.2	0.4
WATER FROM FOOD, g	7	343.8	145.3	54.9	8	324.1	41.3	14.6
WATER FROM FLUIDS, g	7	2834.1	722.3	273.0	8	2166.0	619.0	218.9
TOTAL WATER, g	7	3177.9	730.1	275.9	8	2490.1	621.1	219.6
TOTAL FOOD, g	7	762.3	237.9	99.9	8	738.0	136.6	48.3
TOTAL FOOD, DRY WT	7	418.5	114.5	43.3	8	413.9	107.6	38.1

Table 4b
Intake of Energy and Nutrients: Rest, Pre-exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	Groups Combined			
	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	15	90.1	21.1	5.5
FAT, g	15	90.4	24.2	6.2
CARBOHYDRATES, g	15	216.7	67.3	17.4
K CALORIES	15	2039.6	526.1	135.8
CALCIUM, mg	15	500.8	168.0	43.4
PHOSPHORUS, mg	15	1249.9	308.7	79.7
IRON, mg	15	12.4	2.8	0.7
SODIUM, mg	15	4752.9	1031.5	266.3
POTASSIUM, mg	15	2724.2	542.2	140.0
MAGNESIUM, mg	15	217.9	62.3	16.1
TOTAL VIT. A, IU	15	5971.2	2680.4	692.1
VIT. C, mg	15	93.0	37.5	9.7
THIAMIN, mg	15	3.7	1.5	0.4
RIBOFLAVIN, mg	15	1.7	0.5	0.1
NIACIN, mg	15	20.9	6.3	1.6
PYRIDOXINE, mg	15	2.8	1.1	0.3
WATER FROM FOOD, g	15	333.3	100.0	25.8
WATER FROM FLUIDS, g	15	2477.8	730.9	188.7
TOTAL WATER, g	15	2811.1	739.9	191.0
TOTAL FOOD, g	15	749.3	183.7	47.4
TOTAL FOOD, DRY WT	15	416.0	106.8	27.6

Table 5a
Intake of Energy and Nutrients: Exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	GROUP							
	I: 7/18-24				II: 7/20-26			
	N	Daily Mean Intake	STD DEV	STD ERR	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	7	108.4	28.4	10.7	8	99.2	24.7	8.7
FAT, g	7	110.1	27.2	10.3	8	96.1	36.9	13.1
CARBOHYDRATES, g	7	273.6	77.4	29.3	8	254.1	109.6	38.8
K CALORIES	7	2517.7	590.2	223.1	8	2277.8	848.4	299.9
CALCIUM, mg	7	644.8	164.8	62.3	8	555.2	233.9	82.7
PHOSPHORUS, mg	7	1563.1	330.2	124.8	8	1380.4	393.9	139.3
IRON, mg	7	15.1	3.1	1.2	8	14.9	5.1	1.8
SODIUM, mg	7	5547.5	1034.6	391.0	8	5375.0	1460.1	516.2
POTASSIUM, mg	7	2689.6	639.8	241.8	8	2688.6	798.2	282.2
MAGNESIUM, mg	7	261.4	58.2	22.0	8	263.9	97.3	34.4
TOTAL VIT. A, IU	7	9370.5	3283.0	1240.9	8	7122.0	3362.0	1188.7
VIT. C, mg	7	150.7	66.4	25.1	8	105.7	49.3	17.4
THIAMIN, mg	7	5.0	1.5	0.6	8	4.1	2.4	0.8
RIBOFLAVIN, mg	7	2.1	0.6	0.2	8	1.7	0.8	0.3
NIACIN, mg	7	23.2	5.9	2.2	8	21.9	7.3	2.6
PYRIDOXINE, mg	7	4.5	1.6	0.6	8	3.5	1.4	0.5
WATER FROM FOOD, g	7	389.3	119.3	45.1	8	401.8	127.4	45.1
WATER FROM FLUIDS, g	7	2714.8	431.5	163.1	8	2385.8	540.9	191.2
TOTAL WATER, g	7	3104.1	397.2	150.1	8	2787.5	544.3	192.4
TOTAL FOOD, g	7	904.9	202.9	76.7	8	873.3	268.8	95.0
TOTAL FOOD, DRY WT	7	515.6	119.5	45.2	8	471.5	172.9	61.1

Table 5b
Intake of Energy and Nutrients: Exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	Groups Combined			
	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	15	103.5	25.9	6.7
FAT, g	15	102.6	32.4	8.4
CARBOHYDRATES, g	15	263.2	93.2	24.1
K CALORIES	15	2389.8	724.2	187.0
CALCIUM, mg	15	597.0	202.8	52.4
PHOSPHORUS, mg	15	1465.7	365.0	94.2
IRON, mg	15	15.0	4.1	1.1
SODIUM, mg	15	5455.5	1238.0	319.6
POTASSIUM, mg	15	2689.1	702.8	181.5
MAGNESIUM, mg	15	262.7	78.7	20.3
TOTAL VIT. A, IU	15	8171.3	3408.7	880.1
VIT. C, mg	15	126.7	60.4	15.6
THIAMIN, mg	15	4.5	2.0	0.5
RIBOFLAVIN, mg	15	1.9	0.7	0.2
NIACIN, mg	15	22.5	6.5	1.7
PYRIDOXINE, mg	15	3.9	1.5	0.4
WATER FROM FOOD, g	15	396.0	119.4	30.8
WATER FROM FLUIDS, g	15	2539.3	504.9	130.4
TOTAL WATER, g	15	2935.3	492.4	127.1
TOTAL FOOD, g	15	888.0	232.4	60.0
TOTAL FOOD, DRY WT	15	492.1	146.9	37.9

Table 6a
Intake of Energy and Nutrients: Rest, Post-exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	GROUP							
	I: 7/25-27				II: 7/27			
	N	Daily Mean Intake	STD DEV	STD ERR	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	7	100.7	26.8	10.1	8	82.6	39.9	14.1
FAT, g	7	112.0	20.0	7.6	8	73.4	37.1	13.1
CARBOHYDRATES, g	7	261.5	74.2	28.1	8	172.9	97.9	34.6
K CALORIES	7	2455.7	468.7	177.2	8	1682.2	870.7	307.8
CALCIUM, mg	7	649.8	60.3	22.8	8	423.5	210.5	74.4
PHOSPHORUS, mg	7	1560.1	260.8	98.6	8	1098.7	583.1	206.1
IRON, mg	7	14.1	2.9	1.1	8	12.1	6.1	2.2
SODIUM, mg	7	5306.6	1058.0	399.9	8	4783.8	2717.0	960.6
POTASSIUM, mg	7	2382.7	697.5	263.6	8	2272.1	1224.9	433.1
MAGNESIUM, mg	7	237.4	59.1	22.3	8	199.4	95.9	33.9
TOTAL VIT. A, IU	7	9464.4	1732.3	654.7	8	4507.0	4499.4	1590.8
VIT. C, mg	7	138.4	33.3	12.6	8	65.3	63.1	22.3
THIAMIN, mg	7	5.2	0.6	0.2	8	2.6	1.4	0.5
RIBOFLAVIN, mg	7	2.1	0.4	0.1	8	1.4	0.7	0.2
NIACIN, mg	7	21.1	6.8	2.6	8	16.7	8.0	2.8
PYRIDOXINE, mg	7	4.4	1.1	0.4	8	2.2	1.8	0.6
WATER FROM FOOD, g	7	371.9	132.1	49.9	8	331.7	180.1	63.7
WATER FROM FLUIDS, g	7	2316.0	499.6	188.8	8	2224.4	913.4	322.9
TOTAL WATER, g	7	2687.8	445.7	168.5	8	2556.0	908.9	321.3
TOTAL FOOD, g	7	867.5	208.8	78.9	8	679.3	351.9	124.4
TOTAL FOOD, DRY WT	7	495.6	104.1	39.3	8	347.6	182.2	64.4

Table 6b
Intake of Energy and Nutrients: Rest, Post-exercise Period
Group Means, Standard Deviations, and Standard Error of the Means

	Groups Combined			
	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	15	91.1	34.5	8.9
FAT, g	15	91.4	35.4	9.2
CARBOHYDRATES, g	15	214.2	96.2	24.8
K CALORIES	15	2043.2	795.5	205.4
CALCIUM, mg	15	529.1	193.3	49.9
PHOSPHORUS, mg	15	1314.0	505.9	130.6
IRON, mg	15	13.0	4.8	1.3
SODIUM, mg	15	5027.8	2060.0	531.9
POTASSIUM, mg	15	2323.7	980.8	253.2
MAGNESIUM, mg	15	217.1	80.5	20.8
TOTAL VIT. A, IU	15	6820.4	4238.1	1094.3
VIT. C, mg	15	99.4	62.4	16.1
THIAMIN, mg	15	3.8	1.7	0.4
RIBOFLAVIN, mg	15	1.7	0.6	0.2
NIACIN, mg	15	18.7	7.5	1.9
PYRIDOXINE, mg	15	3.2	1.8	0.5
WATER FROM FOOD, g	15	350.4	155.3	40.1
WATER FROM FLUIDS, g	15	2267.1	725.5	187.3
TOTAL WATER, g	15	2617.5	709.1	183.1
TOTAL FOOD, g	15	767.1	300.1	77.5
TOTAL FOOD, DRY WT	15	416.7	164.6	42.5

Table 7
Intake of Energy and Nutrients: Entire Experiment
Group Means, Standard Deviations, and Standard Error of the Means

	GROUP							
	I: 7/16-27				II: 7/16-27			
	N	Daily Mean Intake	STD DEV	STD ERR	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	7	103.5	24.5	9.3	8	94.7	20.3	7.2
FAT, g	7	108.4	21.7	8.2	8	90.4	28.5	10.1
CARBOHYDRATES, g	7	260.3	69.5	26.3	8	236.3	80.4	28.4
K CALORIES	7	2429.5	496.9	187.8	8	2136.6	632.0	223.5
CALCIUM, mg	7	629.2	120.8	45.6	8	513.6	187.5	66.3
PHOSPHORUS, mg	7	1511.5	277.9	105.0	8	1311.1	324.5	114.7
IRON, mg	7	14.5	2.7	1.0	8	13.8	3.5	1.2
SODIUM, mg	7	5380.4	908.0	343.2	8	5073.7	1044.1	369.1
POTASSIUM, mg	7	2524.6	573.5	216.8	8	2455.4	506.4	179.0
MAGNESIUM, mg	7	248.7	49.3	18.6	8	242.2	72.7	25.7
TOTAL VIT. A, IU	7	8922.4	2492.5	942.1	8	6354.2	2850.9	1007.9
VIT. C, mg	7	139.9	47.7	18.0	8	94.8	43.3	15.3
THIAMIN, mg	7	4.9	1.1	0.4	8	3.7	1.9	0.7
RIBOFLAVIN, mg	7	2.0	0.4	0.2	8	1.7	0.6	0.2
NIACIN, mg	7	22.2	5.4	2.1	8	21.3	6.3	2.2
PYRIDOXINE, mg	7	4.2	[illegible]	[illegible]	[illegible]	[illegible]	1.1	0.4
WATER FROM FOOD, g	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WATER FROM FLUIDS, g	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL WATER, g	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL FOOD, g	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL FOOD, DRY WT	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 8
Intake of Energy and Nutrients: Entire Experiment
Group Means, Standard Deviations, and Standard Error of the Means

	Groups Combined			
	N	Daily Mean Intake	STD DEV	STD ERR
PROTEIN, g	15	98.8	22.0	5.7
FAT, g	15	98.8	26.3	6.8
CARBOHYDRATES, g	15	247.5	73.9	19.1
K CALORIES	15	2273.3	573.1	148.0
CALCIUM, mg	15	567.5	165.5	42.7
PHOSPHORUS, mg	15	1404.6	310.6	80.2
IRON, mg	15	14.1	3.1	0.8
SODIUM, mg	15	5216.8	961.0	248.1
POTASSIUM, mg	15	2487.7	520.0	134.3
MAGNESIUM, mg	15	245.2	60.8	15.7
TOTAL VIT. A, IU	15	7552.7	2912.9	752.1
VIT. C, mg	15	115.8	49.6	12.8
THIAMIN, mg	15	4.3	1.6	0.4
RIBOFLAVIN, mg	15	1.8	0.5	0.1
NIACIN, mg	15	21.7	5.7	1.5
PYRIDOXINE, mg	15	3.6	1.3	0.3
WATER FROM FOOD, g	15	373.5	93.4	24.1
WATER FROM FLUIDS, g	15	2455.8	477.9	123.4
TOTAL WATER, g	15	2829.3	475.9	122.9
TOTAL FOOD, g	15	839.9	178.9	46.2
TOTAL FOOD, DRY WT	15	466.5	115.7	29.9

Table 9a
Mean Daily Intake of Energy and Nutrients On the 7 Days of Exercise: Groups I and II Combined

	Exercise Day							
	1		2		3		4	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	110	15	105	15	97	15	96	15
FAT, g	112	15	104	15	90	15	100	15
CARBOHYDRATES, g	300	15	254	15	256	15	256	15
K CALORIES	2650	15	2371	15	2223	15	2304	15
CALCIUM, mg	644	15	620	15	562	15	558	15
PHOSPHORUS, mg	1578	15	1477	15	1375	15	1394	15
IRON, mg	15.5	15	15.0	15	14.4	15	14.0	15
SODIUM, mg	5728	15	5499	15	5009	15	5236	15
POTASSIUM, mg	2937	15	2609	15	2597	15	2596	15
MAGNESIUM, mg	287	15	266	15	253	15	255	15
TOTAL VIT. A, IU	10023	15	7993	15	8060	15	8200	15
VIT. C, mg	149	15	133	15	118	15	113	15
THIAMIN, mg	5.0	15	4.8	15	4.1	15	4.1	15
RIBOFLAVIN, mg	2.1	15	1.9	15	1.8	15	1.7	15
NIACIN, mg	23.6	15	23.7	15	21.6	15	20.3	15
PYRIDOXINE, mg	4.8	15	3.9	15	3.4	15	3.8	15
WATER FROM FOOD, g	423	15	386	15	405	15	390	15
WATER FROM FLUIDS, g	2072	15	2755	15	2896	15	2401	15
TOTAL WATER, g	2495	15	3141	15	3301	15	2791	15
TOTAL FOOD, g	971	15	872	15	869	15	863	15
TOTAL FOOD, DRY WT	547	15	485	15	464	15	474	15

Table 9b
Mean Daily Intake of Energy and Nutrients On the 7 Days of Exercise: Groups I and II Combined

	Exercise Day					
	5		6		7	
	Daily Mean Intake	N	Daily Mean Intake	N	Daily Mean Intake	N
PROTEIN, g	102	15	111	15	104	15
FAT, g	93	15	109	15	110	15
CARBOHYDRATES, g	247	15	260	15	271	15
K CALORIES	2232	15	2464	15	2485	15
CALCIUM, mg	532	15	605	15	658	15
PHOSPHORUS, mg	1369	15	1554	15	1513	15
IRON, mg	14.7	15	15.7	15	15.8	15
SODIUM, mg	5074	15	5840	15	5802	15
POTASSIUM, mg	2530	15	2722	15	2833	15
MAGNESIUM, mg	242	15	266	15	269	15
TOTAL VIT. A, IU	6304	15	7947	15	8672	15
VIT. C, mg	105	15	122	15	147	15
THIAMIN, mg	3.9	15	4.6	15	5.1	15
RIBOFLAVIN, mg	1.8	15	1.9	15	1.9	15
NIACIN, mg	21.7	15	24.1	15	22.6	15
PYRIDOXINE, mg	3.2	15	3.8	15	4.5	15
WATER FROM FOOD, g	380	15	415	15	372	15
WATER FROM FLUIDS, g	2711	15	2468	15	2473	15
TOTAL WATER, g	3091	15	2883	15	2845	15
TOTAL FOOD, g	843	15	918	15	880	15
TOTAL FOOD, DRY WT	463	15	503	15	508	15

TABLE 9c: MEAN DAILY INTAKE OF ENERGY AND NUTRIENTS DURING THE 7 DAYS OF EXERCISE AT 7200 FT. ALTITUDE EXPRESSED AS PERCENTAGE OF MILITARY RECOMMENDED DIETARY ALLOWANCES (MRDA)

	MRDA	COMBINED GROUPS I AND II % MRDA
PROTEIN, g	100	104
FAT, g (max)[1]	160	64
CARBOHYDRATE, g[2]	440	60
CALORIES, Kcal[3]	3600	67
CALCIUM, mg[4]	800	75
PHOSPHORUS, mg[4]	800	184
IRON, mg[4]	10	150
SODIUM, mg[5]	6120	89
MAGNESIUM, mg[4]	350	75
TOTAL VIT. A, IU	5000	163
VIT. C, mg	60	214
THIAMIN, mg	1.6	281
RIBOFLAVIN, mg	1.9	100
NIACIN, mg NE	21	107
PYRIDOXINE, mg	2.2	177

[1]No minimum value given for fat, % MRDA for fat = % of maximal advised for operational ration content.

[2]No value given for carbohydrate, %MRDA for CHO = % advised for operational ration content.

[3]Upper level of energy requirement for MRDA used (2800-3600 kcal).

[4]When MRDA is given as a range, the lower value of the range was used to calculate %MRDA.

[5]Sodium safe and adequate levels calculated at 1700 mg/1000 kcal of estimated energy requirement.

Table 10a
Frequency of MRE Foods Consumed
CLASS=ENTREE

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
BEEF PAT	41	41	7.780	7.780
BEEF STEW	41	82	7.780	15.560
BEEF W/BQ SA	49	131	9.298	24.858
BEEF/GRAVY	42	173	7.970	32.827
CK A LA KING	53	226	10.057	42.884
FRANKFURT	40	266	7.590	50.474
HAM SLICES	47	313	8.918	59.393
HAM/CK LOAF	45	358	8.539	67.932
MTBALL W/BBQ	43	401	8.159	76.091
PICK SA W/BF	41	442	7.780	83.871
PORK SSG PAT	42	484	7.970	91.841
TURK/GRAVY	43	527	8.159	100.000

Table 10b
Frequency of MRE Foods Consumed
CLASS=SPREAD

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
CHEESE SPR	99	99	42.672	42.672
JELLY	75	174	32.328	75.000
PEANUT BUT	58	232	25.000	100.000

Table10c
Frequency of MRE Foods Consumed
CLASS=STARCH

FOOD	FREQUENCY	FCOD NAME CUM FREQ	PERCENT	CUM PERCENT
BEAN W/TO SA	108	108	24.942	24.942
CRACKERS	283	391	65.358	90.300
POTATO PATTI	42	433	9.700	100.000

Table 10d
Frequency of MRE Foods Consumed
CLASS=FRUITS

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
APPLESAUCE	44	44	22.798	22.798
FRUIT MX DEH	30	74	15.544	38.342
PEACHES FRDH	50	124	25.907	64.249
STRAWBER SW	69	193	35.751	100.000

Table 10e
Frequency of MRE Foods Consumed
CLASS=DESSER

FOOD	FREQUENCY	FCCD NAME CUM FREQ	PERCENT	CUM PERCENT
BROWN CHCV	56	56	18.421	18.421
CH NUT CAKE	33	89	10.855	29.276
CHERRY NTCK	36	125	11.842	41.118
COOKIES CHCV	87	212	28.618	69.737
FRUITCAKE	29	241	9.539	79.276
MAPLE NUT CK	26	267	8.553	87.829
ORANGE/NTROL	6	273	1.974	89.803
PINEA NUT CK	31	304	10.197	100.000

Table 10f
Frequency of MRE Foods Consumed
CLASS=CANDY

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
CANDY	114	114	100.000	100.000

Table 10g
Frequency of MRE Foods Consumed
CLASS=BEVERG

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
COCOA BEV PD	229	229	58.869	58.869
COFFEE INSTA	53	282	13.625	72.494
CREAM SUB ND	52	334	13.368	85.861
SUGAR	55	389	14.139	100.000

Table 10h
Frequency of MRE Foods Consumed
CLASS=CONDMT

FOOD	FREQUENCY	FOOD NAME CUM FREQ	PERCENT	CUM PERCENT
CATSUP	13	13	38.235	38.235
SP/GRAV BASE	21	34	61.765	100.000

Table 10i

Number of Diet Soft Drinks Consumed (Cans)

Regular	Caffeine Free
107	223

TABLE 11: CHANGES IN BODY WEIGHT, % BODY FAT, AND VO_2max IN SUBJECTS CONSUMING THE MRE RATION FOR 12 DAYS AND RUNNING FOR 7 DAYS AT 7,200 FEET ALTITUDE

	Weight (lbs)	Body Fat (%)	VO_2max (L/min)
Pre-experiment	155.5 ± 6.5	14.8 ± 0.9	3.88 ± 0.14
Post-experiment	151.1 ± 6.2	13.3 ± 1.0	3.66 ± 0.14
% Change from Pre-experiment	-2.8	-10.0	-5.7
Significance	$P<0.05$	$P<0.05$	$P<0.01$

TABLE 12: EFFECT OF SEVEN CONTINUOUS DAYS OF RUNNING AT 7200 FEET ALTITUDE ON DAILY MILEAGE, CALORIC INTAKE, BODY WEIGHT, FLUID INTAKE, AND 24 HOUR URINE VOLUME[1]

	Day							
	Sea Level Rest Day	1	2	3	4	5	6	7
Miles run/2 hr	0	10.3	9.8	10.1	10.5	10.5	9.3	10.9
Body weight, lbs	155.5	153.7	153.9	152.6	152.5	152.2	152.3	151.1
Kcal/24 hr	2123	2650	2371	2223	2304	2232	2464	2485
Fluid Intake, ml[2]	2627	2072	2755	2896	2401	2711	2468	2473
Total Water Intake, ml[3]	3025	2495	3141	3301	2791	3091	2883	2845
Urine Volume, ml	947	965	742	827	804	800	944	954

[1] Values shown represent the daily mean for 15 subjects. Day 0 was at rest at sea level prior to traveling to altitude, day 1-7 were exercise days at 7200 ft. altitude.

[2] Fluid intake composed of all fluid sources exclusive of food water.

[3] Total water intake includes fluids and food source water.

TABLE 13: BLOOD CHEMISTRIES[1]

	PRE SEA LEVEL REST DAY 1	ALTITUDE FIRST DAY OF EXERCISE (PRE-RUN)	ALTITUDE FOURTH DAY OF EXERCISE (PRE-RUN)	ALTITUDE SEVENTH DAY OF EXERCISE (PRE-RUN)	POST SEA LEVEL REST DAY 13
Sodium (mmol/l)	139.87 ± 0.56	141.47 ± 0.45*	142.20 ± 0.57*	141.40 ± 0.57*	141.13 ± 0.52*
Potassium (mmol/l)	3.99 ± 0.04[2]	5.01 ± 0.21[2]*	4.66 ± 0.25*	4.40 ± 0.07	4.24 ± 0.06
Chloride (mmol/l)	102.93 ± 0.73	104.93 ± 0.64	104.53 ± 0.69	105.00 ± 0.68	104.86 ± 0.64
Calcium (mg/dl)	9.50 ± 0.09[2]	9.55 ± 0.06[2]	9.77 ± 0.25	9.70 ± 0.07	9.71 ± 0.07
Phosphate (mg/dl)	3.70 ± 0.11[2]	3.57 ± 0.11	3.54 ± 0.10	3.59 ± 0.12	3.77 ± 0.14
Glucose (mg/dl)	85.87 ± 1.72	92.73 ± 2.25*	91.00 ± 2.18	86.00 ± 1.73	80.67 ± 1.61*
Albumin (g/dl)	4.54 ± 0.04	4.76 ± 0.05*	4.80 ± 0.07*	4.62 ± 0.07	4.62 ± 0.06
Total Protein (g/dl)	7.00 ± 0.10	7.27 ± 0.06*	7.39 ± 0.12*	7.11 ± 0.10	7.07 ± 0.07
Lactate (mg/dl)	6.34 ± 0.39	10.17 ± 0.95*	9.73 ± 1.95*	7.69 ± 1.25	7.67 ± 0.85
BUN (mg/dl)	15.1 ± 0.9	14.4 ± 0.9	15.8 ± 0.9	15.6 ± 1.1	14.8 ± 0.6
Creatinine (mg/dl)	1.18 ± 0.03	1.24 ± 0.03	1.25 ± 0.03*	1.19 ± 0.04	1.24 ± 0.04
Glycerol (mmol/L)	0.07 ± 0.01	0.09 ± 0.01	0.11 ± 0.01*	0.09 ± 0.01	0.07 ± 0.01
Cholesterol (mg/dl)	184.07 ± 6.34	185.93 ± 6.30	177.07 ± 7.36*	170.27 ± 7.92*	171.43 ± 7.14*
Triglyceride (mg/dl)	79.54 ± 8.60[3]	61.91 ± 5.92[5]	52.58 ± 4.02[4]	63.91 ± 11.53[5]	78.77 ± 6.45[3]
HD Lipoprotein (mg/dl)	40.67 ± 2.52	40.27 ± 1.87	43.08[3] ± 2.17[3]	39.79 ± 1.05[2]	39.27 ± 1.30

[1] N = 15 except where otherwise indicated
[2] N = 14
[3] N = 13
[4] N = 12
[5] N = 11
* significantly different from pre-experiment rest day. $P<0.05$.

TABLE 14: BLOOD AND URINE B-HYDROXYBUTYRATE[1]

	Pre Sea Level Rest Day 1	Altitude First Day of Exercise	Altitude Fourth Day of Exercise	Altitude Seventh Day of Exercise	Post Sea Level Rest Day 13
Serum, pre-exercise[2]	0.42 ± 0.11	0.62 ± 0.21	0.98 ± 0.27*	0.72 ± 0.19*	0.44 ± 0.08
Serum, Post-exercise[3]	----	1.30 ± 0.27	1.64 ± 0.28	1.21 ± 0.24	----
Urine [4]	0.19 ± 0.14	1.00 ± 0.44	1.53 ± 0.50*	0.37 ± 0.24	0.13 ± 0.09

[1] N = 15, values are x ± SEM (mmol/L)

[2] Samples taken at rest following overnight fast prior to exercise.

[3] Samples taken immediately following 2 hr. of exercise.

[4] Urine B-hydroxybutyrate done on a 24 hr. urine sample. Refer to table 12 for urine volumes.

* Significantly different from pre-experiment sea level rest day, $P < 0.05$.

APPENDIX 1

MRE Food Record Card

PRIVACY ACT COVERED BY THE CONSENT AGREEMENT

FOOD RECORD - MRE

Name _____
Last First Middle Initial

SSN: __ __ __/__ __/__ __ __ __

Date (mo/da/1984) __ __/__ __/8 4

Time (hrs) __ __ __ __

Menu Number (1-12) __ __

1. Breakfast ___ Lunch ___ Supper ___

2. Please check each item you ate and circle the number on the right to show how much you ate.

ENTREE	CHECK ITEMS EATEN	AMOUNT EATEN			
BEEF W/BARBEQUE SAUCE	___	1/4	1/2	3/4	all
BEEF W/GRAVY	___	1/4	1/2	3/4	all
BEEF W/SPICED SAUCE	___	1/4	1/2	3/4	all
BEEF PATTIES	___	1/4	1/2	3/4	all
BEEF STEW	___	1/4	1/2	3/4	all
CHICKEN ALA KING	___	1/4	1/2	3/4	all
FRANKFURTERS	___	1/4	1/2	3/4	all
HAM/CHICKEN LOAF	___	1/4	1/2	3/4	all
HAM SLICES	___	1/4	1/2	3/4	all
MEATBALLS W/BARBEQUE SCE	___	1/4	1/2	3/4	all
PORK SAUSAGE PATTLES	___	1/4	1/2	3/4	all
TURKEY W/GRAVY	___	1/4	1/2	3/4	all
STARCH					
CRACKERS	___	1/4	1/2	3/4	all
BEANS W/TOMATO SAUCE	___	1/4	1/2	3/4	all
POTATO PATTY	___	1/4	1/2	3/4	all
SPREAD					
CHEESE	___	1/4	1/2	3/4	all
JELLY	___	1/4	1/2	3/4	all
PEANUT BUTTER	___	1/4	1/2	3/4	all
FRUIT					
APPLESAUCE	___	1/4	1/2	3/4	all
MIXED FRUITS	___	1/4	1/2	3/4	all
PEACHES	___	1/4	1/2	3/4	all
STRAWBERRIES	___	1/4	1/2	3/4	all
DESSERT					
BROWNIE	___	1/4	1/2	3/4	all
CHERRY NUT CAKE	___	1/4	1/2	3/4	all
CHOCOLATE-COVERED COOKIE	___	1/4	1/2	3/4	all
FRUITCAKE	___	1/4	1/2	3/4	all
MAPLE NUT CAKE	___	1/4	1/2	3/4	all
ORANGE NUT ROLL	___	1/4	1/2	3/4	all
PINEAPPLE NUT CAKE	___	1/4	1/2	3/4	all
CHOCOLATE NUT CAKE	___	1/4	1/2	3/4	all

CONTINUED ON OTHER SIDE

BEVERAGE					
COCOA POWDER	____	1/4	1/2	3/4	all
COFFEE	____	1/4	1/2	3/4	all
CREAM SUBSTITUTE	____	1/4	1/2	3/4	all
SUGAR	____	1/4	1/2	3/4	all
OTHER					
CATSUP	____	1/4	1/2	3/4	all
GRAVY BASE	____	1/4	1/2	3/4	all
CANDY	____	1/4	1/2	3/4	all

3. List other foods eaten, not from this menu pack, that you saved from an earlier meal or received from someone else. Circle the number on the right to show how much you ate.

FOOD	AMOUNT EATEN			
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all
_____	1/4	1/2	3/4	all

4. Circle the number of cans of diet soft drinks consumed.

Regular 1 2 3 4 5 _____

Caffeine Free 1 2 3 4 5 _____

5. Estimate number of cups of water consumed between the completion of your last meal and this meal. Please circle the amount of water consumed.

Water 1 2 3 4 5 _____

6. Comments.

Please return the card when you are through filling it out.

THANK YOU

REFERENCES

1. Brown, M. Fast Food in the Field. Soldiers 39:24-26, 1984.
2. Hirsch, E., Meiselman, J.L., Popper, R.D., Smits, G., Jezior, B., Lichton, I., Wenkan, N., Burt, J., Fox, M., McNutt, S., Thiele, M.N., and Dirige, O. The Effects of Prolonged Feeding of Meal, Ready-to-Eat (MRE) Operational Rations. U.S. Army NRDC Technical Report Natick/TR-85/035, October 1984.
3. Scrimshaw, N.S., Udall, J.N., and Lo, C. The Evaluation of the Tolerability and Nutritive Value of a Currently Used Combat Ration. Massachusetts Institute of Technology, Department of Nutrition and Food Science, Cambridge, Massachusetts, 1983 (exact reference not available, contact Dr. E. Hirsch, Natick Laboratories for further information.)
4. Durnin, J.V.G.A., and Womersley, J. Body Fat Assessed from Total Body Density and Its Estimation from Skinfold Thickness. Measurements on 481 Men and Women Aged from 16 to 72 Years. Brit. J. Nutr. 32:77-97, 1974.
5. McArdle, W.D. Comparison of Continuous and Discontinuous Treadmill and Bicycle Tests for Max VO_2. Med. Sci. Sports 5:156-160, 1973.
6. Norton, A.C. Development and Testing of a Microprocessor-Controlled System for Measurement of Gas Exchange and Related Variables in Man During Rest and Exercise. Beckman Reprint No. 025, 1983.
7. ----------. A-gent HDL, High Density Lipoprotein. Abbott Laboratories Diagnostics Division, South Pasadena, CA. June 1979.
8. McGarry, J.D., Guest, M.J. and Foster, D.M. Ketone Body Metabolism in Ketosis of Starvation and Alloxan Diabetes. J. Biol. Chem 245:4382-4390, 1970.
9. Spinella, C.J. and Mager, M. Modified Enzymatic Procedure for the

Routine Determination of Glycerol and Triglycerides in Plasma. J. Lipid Res. 7:167-169, 1966.

10. ---------. The Quantitative Determination of Lactic Acid in Whole Blood. Sigma Technical Bulletin No. 826-UV Sigma Chemical Company, St. Louis, MO. December, 1980.

11. ---------. The T-test Procedure. SAS User's Guide: Statistics, 1982, pp 217-221.

12. Steel, G.D., and Torrie, J.H. Principles and Procedures of Statistics. McGraw-Hill, lNew York, 1960, pp 78-80.

13. ---------. Nutrition Allowances, Standards, and Education. Army Regulation 40-25, Headquarters, Department of the Army, Washington, D.C. 15 May 1985.

14. Sherman, W.M., and Costill, D.L. The Marathon: Dietary Manipulation to Optimize Performance. Amer. J. Sports Med. 12:44-51, 1984.

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